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J. R. Reitz
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SUPERCONDUCTIVITY AT HIGH PRESSURES

In an attempt to learn more about the fundamental nature of superconductivity, Professor G.O. Jones and Dr. Chester (Queen Mary College, London) have studied the superconducting transition at pressures up to 40,000 atmospheres. The high pressures were produced by the Bridgman crossed-knife-edge method; the specimen to be studied was placed in a clamp as is shown in Fig. 1, which was subjected to 10 tons of force at room temperature. The clamp was screwed down while it was in the hydraulic press, and upon removal it was found that most of the high pressure on the sample was maintained.

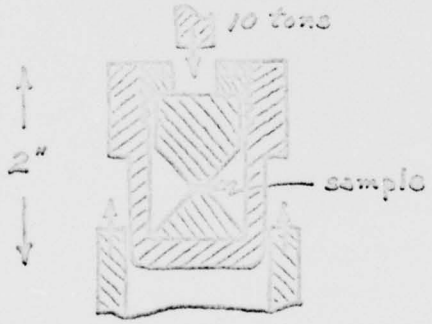

Fig. 1. Clamp for maintaining high pressure on the sample.

The actual amount of pressure retained on the sample was measured by means of strain gauges. The clamp, which was quite small, was then placed in a cryostat and cooled to liquid helium temperatures, and the study of the superconducting transition was made by means of magnetic measurements.

The clamp was made entirely of the same material (Be-Cu) so that no differential thermal expansion would take place when the temperature was lowered. Thus Jones and Chester believe that the pressure was maintained on the sample at the liquid helium temperature and, furthermore, from observations on deformed specimens they concluded that over 75 per cent of the volume of the sample was under hydrostatic pressure. These experiments are thus entirely different from those performed by Hilsch (cf. Technical Report CNRL-9-53) who studied the effect of cold work on superconducting specimens at low temperatures.

The results on tin show that the superconducting transition temperature, T_c, drops to about 3°K at 40,000 atmospheres. Using Bridgman's values for the compressibility of tin, Jones and Chester have plotted T_c against $-\Delta V/V$ and found a straight line relationship with a slope of about 25°K. The Russian results (1944) on the transition point of tin up to 2,000 atmospheres also fall on this line. Jones and Chester have also investigated thallium which the Russian scientists claim has an increase in T_c with pressure. The new results by Jones and Chester, however, up to pressures of 40,000 atmospheres show that T_c decreases with increase in pressure, but the effect is smaller than for tin. Bismuth, which is not normally a superconductor, was also investigated; it was found that bismuth becomes a superconductor under pressures exceeding 20,000 atmospheres with $T_c = 7°K$.

No significant change in T_c was observed in the range 20,000 - 41,000 atmospheres. This change from a non-superconductor to a superconductor in bismuth is a reversible effect; if the pressure is removed bismuth returns to its normal non-superconducting state. Calcium and strontium which are suggested as borderline superconductors (Fröhlich-Bardeen theory) were investigated but were not found to undergo a superconducting transition at any temperature under pressures up to 40,000 atmospheres.

THE SCATTERING OF NEUTRONS BY IRON NEAR THE CURIE TEMPERATURE

Dr. G. L. Squires (A.E.R.E., Harwell) has obtained a rather striking curve of total neutron cross-section as a function of temperature for iron. He used the reactor BEPO as a source of slow neutrons which passed through a filter made of lead shot. This filter acts on the usual principle that neutrons of wavelength smaller than twice the maximum spacing of crystal planes will tend to be reflected out of the beam (from the Bragg relation) while those of longer wavelength will pass on through the lead undeviated. In practice this filter yields a number distribution in neutron wavelength characterized by a peak at 7.0 A and extending from 5.5 to about 8.5 A. The corresponding maximum wavelength limit for iron would be 4.0 A.

Squires investigated the transmission of these neutrons through a sample of iron maintained in a furnace at various temperatures. He has obtained the curve shown in Fig. 1. The principal uncertainty in the temperature at present lies in the calibration of the thermocouple used. The temperature of the very sharp peak at 1046 ± 5°K is to be compared with

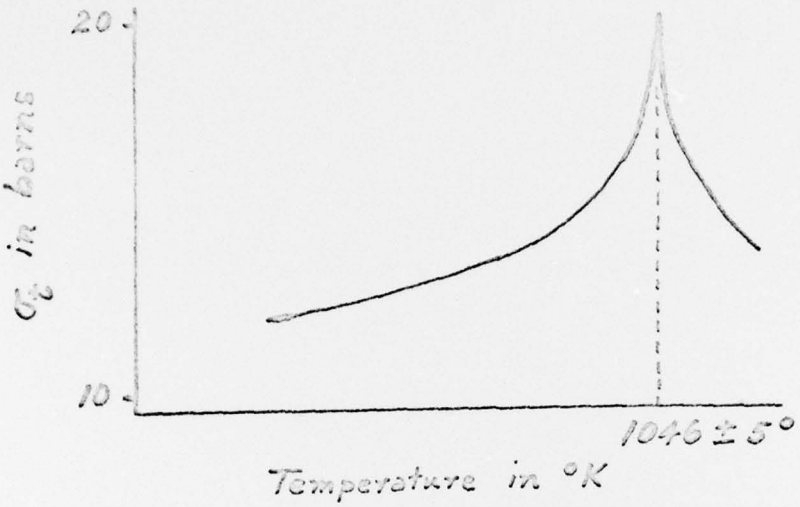

Fig. 1. Total neutron cross section as a function of temperature for iron.

the accepted value of 1043°K for the ferromagnetic Curie point of iron. Using other methods of producing monochromatic neutrons, Squires has verified the fact that for these low neutron energies (below Bragg reflection) the cross section is proportional to the wavelength. However, because of the small neutron fluxes produced by these other methods the variation of cross section with temperature gives a much more rounded peak than in the case of the filter method above.

The theoretical explanation of this behavior of the cross section near the Curie point has not been worked out. R. G. Moorhouse (Proc. Phys. Soc. 64A, 1097 (1951)) has discussed the general question of the slow neutron scattering by ferromagnetic crystals but his considerations do not apply near the Curie temperature. It is interesting to note the similarity in shape between Squires' curve and that for the specific heat of a ferromagnetic substance.

PARALLEL PLATE SPARK COUNTER

Dr. F. Bella and Dr. C. Franzinetti, both of the Nuclear Physics Institute of the University of Rome, have developed a spark counter which apparently works extremely well for long periods of time. Such a counter is of great value for experiments involving severe requirements of time resolution (of the order of 10^{-9} seconds) and also of space resolution, since it is possible to observe the location of a charged particle in the counter by means of the spark which it produces there. In the parallel plate spark counter developed by the Rome group the best results were obtained using an argon-alcohol mixture, of 340 mm Hg of argon and 40 mm Hg alcohol at 10° to 40°C.

The output pulse is found to be several hundred volts and the lifetime of the counter at least 3×10^5 counts/cm^2. However, even if the gas pressure and the plate separation are correctly chosen, the efficiency depends strongly on the direction of the incident particle. External quenching is necessary, but too short a

quenching time shortens the counter plateau.

Bella and Franzinetti tried to explain the operation of the counter in terms of Meek's theory of the spark. Agreement can be obtained in relating the experimental curves to the theoretical ones if the ionization coefficient given by the Townsend relation is used. It is only necessary to make a reasonable assumption about the ratio of applied field to the radial field due to the positive space charge and the lateral speed of the avalanche.

PHOTOMULTIPLIER WITH LARGE CATHODE

The Electric and Musical Industries Research Laboratories of Hayes, Middlesex (E.M.I.), have recently announced the production of a new photomultiplier tube with an unusually large photocathode. The multiplier may be expected to have uses with scintillation counters having very large crystals for maximum gamma sensitivity, or it can be used with a thin screen of phosphor for the detection of low energy alpha particles, for instance in the monitoring of radioactive contamination in isotope laboratories where it may be necessary to search very large areas.

The effective diameter of the photocathode is 4½ inches, and the cathode area is flat. A simple electron lens images the photoelectrons onto the entrance of an eleven-stage multiplier of the Venetian blind type commonly used by E.M.I. The cathode sensitivity is comparable with other multipliers, that is,

more than 20 microamps per lumen. The photocathode is of the cesium-antimony semi-transparent type with a peak of response at about 4100 A.

SIXTH INTERNATIONAL CONGRESS OF MICROBIOLOGY, ROME

The Sixth International Congress of Microbiology, held in Rome on 6 - 12 September 1953, was attended by about 3,000 scientists, approximately 700 of whom were from the United States. Because the meetings took place over a large physical area with many of the sections in simultaneous session, a complete résumé of the material is not feasible. Abstracts of the papers were available to registered members of the Congress and the entire Proceedings will be published some time next year. Abstracts of five papers on virus research are given below.

Autointerference by Vaccinia Virus

L. H. Collier of the Lister Institute of Preventive Medicine, Elstree, Hertfordshire, prepared a number of suspensions of vaccinia virus in both freeze-dried and liquid forms; these were stored at 4°, 22° or 37°C and were titrated at intervals by intracutaneous injection of ascending tenfold dilutions in rabbits. It was noted that stored preparations often gave abnormal skin reactions when tested by this method, the lesions being unusually pale in color and poorly indurated. Abnormally small lesions were produced by the lower dilutions of virus, and there was no diminution in size of the papules with ascending dilution.

A survey of more than 500 titrations showed a statistically significant increase of this type of reaction in tests of freeze-dried preparations as compared with liquid suspensions. The abnormal reactions also occurred significantly more often in tests of material stored at 22° and 37° as compared with that held at 4°, while the period of greatest frequency seemed to be from the 9th to 16th week of storage.

These abnormal reactions were not due to alterations in sensitivity of the test animals, firstly because they were often seen alongside perfectly normal lesions produced by a different titration on the same rabbit, and secondly because their distribution was not random throughout the entire series of tests on different categories of stored preparations.

This type of reaction was never seen with titrations of fresh virus; this raised the possibility that the dead virus in partially inactivated stored preparations was interfering with the proliferation of the remaining living vaccinia in the rabbit dermis.

To test this theory, constant amounts of vaccinia which had been inactivated in various ways (interfering virus) were added to ascending dilutions of fresh virus, and the mixtures injected intracutaneously. Negative or equivocal results were obtained when the interfering virus was completely inactivated by storage in the liquid state at 37°, or by irradiation with ultraviolet light. When the interfering virus was freeze dried in 5 per cent peptone and partially inactivated by storage at 37° or 45°, however, lesions were produced which were much paler and less indurated than control lesions produced by fresh virus alone.

Preliminary experiments suggest that a critical proportion of inactive to active virus may be necessary to produce this type of lesion, which resembled those seen during the tests of stored vaccinial suspensions.

The abnormal titration results may therefore have been due to autointerference by inactivated virus; it is suggested that stored preparations of vaccinia may pass through a stage when the proportion of inactive to active virus is optimal for the occurrence of interference.

No evidence of interference by inactive virus has been obtained using the scarification method of inoculation in rabbits, but attempts are being made to elicit this phenomenon by inoculation of the chorioallantoic membranes of embryonated eggs. Work is in progress to determine the active virus content of the intracutaneous lesions, and a study of their histology is also to be made.

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The Agglutination of Spermatozoa by Viruses of Influenza, Mumps and Newcastle Disease

The high affinity of mumps and many other viruses to testicular tissue and the possibility of obtaining a pure suspension of spermatozoa led H. P. Chu of the Department of Animal Pathology, University of Cambridge, to make a study of the interaction between some viruses and spermatozoa. It was found that human, bovine and avian spermatozoa were agglutinated by viruses of influenza A and B, swine influenza, mumps and Newcastle disease. Allantoic fluid of embryonated eggs infected with these viruses can agglutinate a 1 per cent suspension of fowl spermatozoa at titers

of from 60-1260. Macroscopically the agglutination is very similar to bacterial agglutination and can be readily detected. The spermagglutination is not produced by viruses of vaccinia or infectious chick bronchitis. The spermagglutinating activity of other viruses has not been tested.

The mechanism of the agglutination of spermatozoa by these viruses is very similar to that of the agglutination of red blood cells. The spermagglutinin is associated with the virus particles and is probably identical with the hemagglutinin. Viruses adsorbed with and eluted from red blood cells will agglutinate spermatozoa and vice versa. Like the hemagglutination, the spermagglutination can be specifically inhibited by antibodies against these viruses.

The spermagglutination can also be inhibited by the Frances inhibitor present in normal serum. Similarly, inhibitors were found in the seminal fluid and in the extracts of spermatozoa and of testicular tissue. These inhibitors act on spermagglutinin as well as on hemagglutinin.

The extensive investigation on virus hemagglutination has produced much information on the first stage of virus-host cell interaction -- i.e., the specific adsorption of viruses on the host cell. For the study of the further stages of virus-host cell interaction, the spermatozoa and viruses system may be more satisfactory than that of red cells and viruses. Since in contrast to the red cells, the spermatozoa and more particularly the spermatogonia are growing cells with active nucleic acid metabolism, it may be possible to adapt some viruses to grow in an in vitro culture of spermatozoa or spermatogonia and to use the

system for the study of the effect of viruses on the metabolic activity of the host cells.

Electron micrographs and photomicrographs showing the adsorption of the viruses on the head and on the tail of spermatozoa and how the latter are agglutinated were presented at the Congress.

Growth Curves of Fowl-Plague, Newcastle Disease and N-Virus in Deembryonated Eggs

The rate of growth of three kinds of viruses (fowl-plague, Newcastle disease, and Virus N) was comparatively investigated by C. Hallauer of the Hygienisch-bakteriologisches Institut der Universität, Bern, Switzerland, by hemagglutination and infectivity tests in deembryonated eggs. A large amount of seed virus (10^7-10^9 ID_{50}) provided a full virus saturation of the allantoic membrane. The extent of the absorption varied from 75-95 per cent for fowl-plague and 75-85 per cent for Newcastle disease and N-virus, but only 1.3 per cent of this amount calculated to be adsorbed was actually found in the chorionallantoic membrane. In this respect Henle's similar observation with influenza virus was confirmed. As expected, the constant period (phase of non-multiplication) was shown to be dependent on the amount of seed virus inoculated. With the employed high doses this period was as short as 1½, 2 and 3 hours for Virus N, fowl-plague and Newcastle-disease viruses respectively. In the period of progressive propagation which was controlled over 9-12 hours the titer of infectivity in the allantoic membrane rose sharply within 3-4 hours followed by only a slight additional increase thereafter. The peak of infectivity was generally

reached between 6 and 9 hours after infection with fowl-plague and N-virus, but usually not before the 12th hour with Newcastle-disease virus. In the case of fowl-plague and Newcastle-disease virus the first detection of hemagglutinin in the allantoic membrane was never successful before infectivity increased. With Virus N, on the other hand, the hemagglutinin was occasionally detectable one hour before, and in this respect showed the behavior of influenza virus strains. The ratio between infectivity and hemagglutinin titers found in the allantoic membrane remained fairly constant during the period of observation in experiments with fowl-plague and Newcastle-disease virus, i.e., about 10^5 ID_{50}/1 H.U. On the other hand no such proportionality could be found with Virus N, since this ratio changed considerably, i.e., from $10^{4.5}$ ID_{50}/1 H.U. in the beginning to about 10^3 ID_{50}/1 H.U. at the end of the period of growth. It seems therefore that hemagglutinin of Virus N is not only prematurely built up but is also produced in an excessive amount in a later phase when infectivity remains constant or even decreases. This fact would be in agreement with the observed auto-interfering capacity of this kind of virus. The release of virus (hemagglutinin, infectious units) in the liquid (Tyrode's solution) set in generally within one hour after the first detectable increase of virus in allantoic membrane. The yield of hemagglutinins liberated during the period of observation was fairly constant, and amounted to about 16, 64 and 128 H.U./1 for fowl-plague, Newcastle disease and N-virus respectively. The duration of virus production has not yet been thoroughly studied, but it has been demonstrated that the production of hemagglutinins lasted 2-5 days beyond

the natural death of the infected eggs, although in a progressively diminishing degree.

Cellular Changes in the Mouse Pancreas Caused by Coxsackie Virus Infection

Multiplication of certain strains of Coxsackie virus in the adult mouse pancreas has been described by A. M. Pappenheimer, L. J. Kunz, and S. Richardson, J. Exp. Med. 94, 45 (1951). In experiments by A. D. Vizoso and F. K. Sanders of the Department of Zoology and Comparative Anatomy, University of Oxford, an attempt has been made to correlate the growth of one such strain with the histopathological changes in the infected tissue. New virus first appears in the pancreas 24-36 hours after the intraperitoneal injection of virus. Thereafter the virus content of the infected tissue rises rapidly to reach, by about 48 hours, a maximum level which is maintained until about 100 hours after injection. The virus content then falls to reach a minimum about one week after injection, the onset of the decline in virus content being correlated with the appearance of serum neutralizing antibody.

The first histological sign of infection precedes the appearance of detectable new virus by about 12 hours, and consists in the appearance of an increased number of mitoses in the acinar tissue. Immediately afterwards acinar cells with pyknotic nuclei can be seen, many of them containing two such nuclei, which suggests that some cells may reach the telophase of mitosis and then be unable to complete their division. At the same time acidophilia of the cytoplasm of the infected cells becomes apparent, followed by loss of nuclei and destruction of the cell remnants. These

changes can all be found in the tissue as early as 24 hours after infection, when, after the intraperitoneal injection of large amounts (6×10^5 suckling mouse LD_{50}) of virus, numerous groups of such damaged cells can be found. From these foci the infectious process spreads, in many cases to involve the entire pancreas. Inflammatory changes are not marked until the fourth day after infection.

The Titration in Culture of the Virus of Foot-and-Mouth Disease

J. B. Brooksby of the Research Institute, Animal Virus Diseases, Pirbright, Surrey, has found that the method devised by H. S. Frenkel, Bull. Off. Int. Epiz. 28, 155 (1947), for the growth of the virus of foot-and-mouth disease in surviving epithelial tissue from the tongues of cattle has its greatest application in the cultivation of virus for vaccine production. Frenkel (H. S. Frenkel, and H. H. J. Fredericks, Nature 164, 235 (1949)) has himself suggested its use for typing strains of virus, but the further application of this method to the titration of virus has not so far been described. The technique which has been adopted in the present work is in general similar to that of Fulton and Armitage (Journal of Hygiene 49, 247 (1951)) for the virus of influenza, tongue epithelium taking the place of the chorio-allantoic membrane as the tissue and complement fixation that of hemagglutination as the test for the growth of the virus.

The numerous small cultures required for titration have been made both in 1 oz. screw-capped bottles and in the cups of a moulded plexiglass

sheet similar to those used by Fulton and Armitage. In either case, several fragments of tissue, about 1 mm. in diameter are suspended in 0.3 to 1.0 ml. of a simple buffered glucose solution. A series of such small cultures is inoculated with serial dilutions of the material to be titrated. After incubation, with shaking, for 48-60 hours, the fluids from individual cultures are tested for their ability to fix two 50 per cent units of complement with the appropriate antiserum. In the case of the cultures on plexiglass plates, the complement fixation test can be carried out directly in the cups on the plates. The presence of the tissue does not appear to interfere with the conduct of the test. On the basis of the positive and negative complement fixation results, the 50 per cent end-point for the titration is calculated by the method of Reed and Muench. The determination of end-points obtained in this way, from inoculation of groups of 10 small cultures with each dilution in series, appear to have a precision almost equal to that made from similar numbers of observations in cattle titrations. Agreement between culture end-points and those for titrations in animals in several tests has so far been good although the culture end-point is in general somewhat lower, perhaps as much as tenfold. Further work on this comparison is in progress. This method should have wide application for comparison within a series of experiments such as, for example, to determine the sedimentation of virus in the ultracentrifuge.

TECHNICAL REPORTS OF ONRL

The following reports have been forwarded to ONR, Washington. Copies may be obtained by

addressing requests to the Commanding Officer, Office of Naval Research Branch Office, Navy No. 100, c/o Fleet Post Office, New York, N. Y.

ONRL-121-53 "Some Aspects of Medical Education and Medical Thinking in the U.S.S.R." by J. L. Tullis

ONRL-122-53 "The Physiological Society Meeting at the University of Leeds, Sept. 24 and 25, 1953" by J. L. Nickerson

RADAR RESEARCH ESTABLISHMENT, GREAT MALVERN

The Ministry of Supply has announced that on 1 September 1953 the Telecommunications Research Establishment (T.R.E.) and the Radar Research and Development Establishment (R.R.D.E.), both situated at Great Malvern, were combined under one directorate called Radar Research Establishment (R.R.E.). Mr. W. J. Richards, formerly Chief Superintendent at T.R.E., is now director of the combined establishment. Both divisions will continue to occupy their old quarters; what was formerly T.R.E. is now referred to as the St. Andrews Road Section, and what was formerly R.R.D.E. is now known as the Leigh Sinton Road Section.

Prepared by the Scientific Staff
Edited by J. R. Reitz
Submitted by Dr. E. Epremian
Assistant Scientific Director

W. S. CREASOR
Captain, U.S.N.
Assistant Naval Attache for Research

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